OBSERVATIONS ON THE LIFE HISTORY OF *HYPOTHYCE MIXTA* HOWDEN (COLEOPTERA: SCARABAEIDAE)

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Abstract

Adult *Hypothyce mixta* Howden were collected in the field, and their eggs and early larvae were reared under laboratory conditions. Adult specimens from a natural population sampled in 2 successive years were measured and compared. The entire mating procedure was photographed on movie film. Adults apparently did not eat and appeared to have a vestigial digestive system.

Introduction

In 1962, W. W. Gibson observed a unique male scarab beetle in a student's insect collection. He sent the beetle to H. F. Howden, then with the Canadian Department of Agriculture, and received word that it apparently represented an undescribed genus. Later, Howden, Gibson, and L. J. Bottimer returned to the exact locality where the first specimen had been collected (Tennessee Colony area in Anderson County, Texas) and, using a blacklight, collected another male. In June 1967 Gibson found a female digging in loose sand at Camp Whispering Pines, a Girl Scout Camp near Garrison, Texas. This specimen later became the allotype of the species and established a new locality. Howden (1968) published the description of the new genus, with *Hypothyce mixta* as the type species. By this time, specimens (which later became paratypes) had been collected from Nacogdoches, Texas and several other East Texas localities.

In an attempt to gain information concerning its life history, 2 students at Stephen F. Austin State University attempted, in 1969, to determine the adult food and to rear the larvae from eggs laid by field-collected adults. Beetles had no interest in foods offered, and eggs failed to hatch. With this background, research was conducted in 1971 to determine the natural history of *H. mixta,* and the results of that research are reported here.

Methods and Materials

Adult male *H. mixta* were collected at the Whispering Pines Girl Scout Camp. Many were picked from window screens of a building where they had flown to lights the night before; others were caught during mid to late afternoon with a butterfly net as they flew over the soil surface. Females were collected by hand, following observation of where males landed. However, a few females were spotted as they sat solitary on the ground after emergence from their burrows. Special efforts were made to collect virgin females (i.e., beating the male to a female or separating a pair before mating could occur).

Once captured, specimens were transported in bottles or cans. Although several males were put in a single container, females were always kept solitary. Males were maintained in the laboratory in 5 gallon aquaria which were covered by fine mesh wire or glass. Moisture was provided by moist paper towels in Syracuse dishes in the aquaria. Sandy soil with its usual components of twigs, pine needles and other debris was collected at the site of adult collection and placed in the aquaria as a substrate.

Females were caged individually in pint sized polyethylene freezer boxes and readily burrowed into ca. 3 inches of soil in each box. When the female emerged from the soil, it was assumed that she was ready to mate, and the entire box was transferred to an aquarium containing males. After a male flew into the box and mating had occurred, the box containing both male and female was removed and the male caged separately so as to determine his length of life following mating. Similar longevity data were obtained for the females.

Each box of sand containing a mated female was emptied daily to check for eggs. Eggs were removed, counted, and placed in salve cans with just enough sterilized soil to cover them. (Soil taken from the site of adult collection was placed in a covered coffee can with a small amount of water and heated for 1 hour at 300-400° F. This was considered sufficient to kill fungi or bacteria which might damage the eggs.) One to 4 depressions were made in the sand of each of the salve cans, and 1 egg was placed in each depression. A camel-hair brush was then used to cover the eggs with a thin layer of soil. Records were kept on the development of each female's eggs.

Not all eggs, contained in a given salve can, hatched on the same day; thus, the boxes were checked daily, and the larvae were removed on the day of their hatching. Each larva was moved to a separate salve can, supplied with sterilized, moist soil and given sprouted rye grass as food.

Phylogeny, Habitat, & Biology

Phylogeny: The combination of characters exhibited by *Hypothyce* indicates that it is closely related to *Thyce* LeConte (primarily on the U.S. West Coast) and *Hypotrichia* LeConte (primarily in Florida). However, if the generic limits of either of these genera were to be broadened to include this new beetle discovered in East Texas, it would necessitate the combination of *Thyce, Hypotrichia* and a third genus, *Plectrodes* Horn (a genus from California), into one genus. The combination of these 3 genera plus the widespread genus *Polyphylla* Harris with its variable antennal count, would create an artificial assemblage of some "distinctly divergent" species; therefore, a new monotypic genus, *Hypothyce,* was erected to include *Hypothyce mixta.* (Howden 1968). Hardy (1974) reviewed the phylogenetic status of *Hypothyce* and moved *Thyce osburmi* into *Hypothyce,* making a second species in the genus.

Habitat: *Hypothyce* adults and larvae occur in isolated, sandy areas which are sparsely covered with hardwood, pine, and herbaceous vegetation. The collection site at Camp Whispering Pines consisted of slightly rolling to flat, sandy terrain with scattered pines, hardwoods (sassafras, ash, sweetgum, etc.) and small herbaceous plants. No beetles were found where a thick canopy was present or where trees of any kind were totally absent.

Biology: Measurements of males and females from 2 annual popula-

tions collected in 1970 and 1971 from the Girl Scout Camp fell within the extremes for the species as described by Howden. From clypeus to pygidium, a total of 88 males from both populations ranged from 15.1 to 18.0mm with an average of 16.7mm and a standard deviation of 0.527. Body width at the humeral area of these males ranged from 6.1 to 8.0mm with a mean of 7.0mm and standard deviation of 0.108. Only 10 females were collected during both years; thus, no accurate conclusions could be reached as to their mean size. However, the largest and smallest females collected were 21.2 × 9.5mm and 18.5 × 8.1mm, respectively.

Adult beetles were active over a 6 to 8 week period during early June to late July. Regular collection of adults occurred from 6 June to 12 July, 1971 with scattered individuals being collected as late as 25 July, 1971.

Male *Hypothyce* have well-developed wings and fly readily and strongly. Contrastingly, females also have well-developed wings, but were never observed to fly or even to separate the elytra. Manual separation of the female elytra revealed a pair of well-veinated, seemingly strong wings; however, when left in open containers, handled, or dropped from various heights, the females were never induced to fly.

Adult *Hypothyce* did not eat, although many sources of food existing in their natural habitat were offered to them. Dissection of adult specimens showed that both males and females had a digestive system consisting of a narrow, thin-walled, undifferentiated tube running from mouth to anus. The lack of specialized areas in the tube, the extreme thinness of the tube and the lack of feces in cages from any field-collected specimens led to the conclusion that the digestive system was non-functional.

Mating Procedure

Mating of *H. mixta* was observed both in the field and in the laboratory. In the field, males were somewhat active most of any given 24 hour period; however, a large concentration of their activity occurred in a 2 to 3 hour period beginning around 1700 hours Central Daylight Time. During this time, males were observed flying about 1 foot above ground level or sitting on stationary objects well above ground level. The lamellate antennae of the males was open during this time, thus increasing the surface area of the antennae and, accordingly, the capability of receiving any stimulus of a nearby female (assuming that such a stimulus could be received by the antennae). Males sat motionless for hours in such a position. Suddenly, in what appeared to be stimulation from a female, he would wave his antennae, spread his elytra, and quickly fly almost directly to her. He would land, sometimes upside down, and begin a scrambling, hyperactive search for her. Occasionally, several males landed in the vicinity of a female at approximately the same time; however, the first one to find her was the one with which she mated.

Sight apparently played little or no role in finding the female. Often a male would be within a few inches of a female, even facing her, but seemingly could not find her. Often, too, a male would contact the female but in his hyperactive state of trying to mate with her would climb completely over her body. He would then extend his antennae and circle to locate the female, thus leading us to believe that wind direction and scent were important in the ability of a male to locate a female.

Once a male contacted a female, mating proceeded rapidly. First, the male approached the female laterally and moved directly to her posterior or made a 270 degree turn around her. In either case the male usually reached the female's posterior within a few seconds of coming into contact with her. He then crawled onto her dorsal surface, hooked his anterior tarsal claws under the lateral edges of her elytra, extended his aedeagus, and mated with her. Actual copulation time ranged from 35 seconds to just over 2 minutes as observed both in the lab and the field.

Females were also most active during the 2 to 3 hour period mentioned above. They emerged from holes in the ground just slightly larger than their own diameter. Each hole was assumed to be an original emergence hole for 2 reasons: 1) a female was found there, and females apparently do not fly, nor do they walk much, and 2) holes had been dug apparently from below, as evidenced by the lack of loose soil around them. A female would appear at the entrance of the hole, leave it just long enough to turn around, and then, with most of her body above ground level, would begin to pump her abdominal area up and down with much the same motion used in stridulation. Although not proven, it was assumed that the females were releasing a pheromone during this pumping action. This assumption was substantiated by the fact that males would appear and make contact with a female within 30 seconds of her pumping action. In the laboratory, males were observed to fly directly to a female acting similarly from distances up to 3 feet (with negligible wind) in less than 30 seconds.

Almost immediately following the male's insertion of the aedeagus, the female began to crawl back down the hole from which she came. Usually, the male would "ride" on the female into the hole and continue mating but would emerge a few minutes later. Sometimes the male would be loosened from her back as she descended.

Oviposition

Females burrowed through the soil following copulation and deposited their eggs in a scattered fashion as they burrowed. Most eggs were deposited at the bottoms of the containers in which the females were housed perhaps indicating that their pint box habitats kept them from ovipositing as they normally would in nature.

The average number of days which elapsed between copulation and oviposition was 4.7. One female oviposited the first day following copulation, while another oviposited 6 days following copulation. There were 2 females which oviposited on 2 separate days with almost an entire 24 hour period between them. In all, 5 females laid a total of 109 eggs with a range of 9 to 30 and an average of 18.8 per female. One of the 6 collected in 1971, for unknown reasons, did not oviposit following copulation.

Eggs

At the time of oviposition, eggs were dull white in color, elliptical in shape and averaged 3.0mm long. Many darkened to a tan color in the following 24 hours. The usual sticky secretion from colleterial glands was present on the surface, making soil particles stick to the eggs. Hayes (1929) had observed this on other scarab eggs.

Average incubation time was approximately 20 days. After 10 days of

incubation, several eggs examined had increased to an average of 4.5mm in length. Very little additional increase in size occurred prior to hatching. During the last 1 to 2 days before hatching, mandibles, head capsules, antennae and eyes were distinctly visible through the shell, and all eggs had discolored to various shades of tan. With few exceptions all the eggs laid by a given female on a single day hatched within a few hours of each other.

First Instar Larvae

The larvae emerged from the eggs head-first following a splitting of the egg shell longitudinally along the dorsal surface of the larva. Within a day after hatching, several larvae were measured and found to average 4.0mm long and 1.5mm wide at the thorax. The antennae, head, and mandibles were brown, while the rest of the body was a dull white with sparse brown pigmented areas. After beginning to eat, the *Hypothyce* larvae, like other scarab larvae, took on a dark coloration in the abdominal area due to a concentration of fecal materials and sand taken in during feeding.

At first many larvae died from unsuitable food. Offerings of moistened oats, cereals, sprouted corn, and freshly sprouted rye grass were made. Of these only the rye grass was accepted, and the larvae accepting it were those which lived the longest.

Larvae fed by lying on their dorsal surface and clutching a rye grass stem or root with their first 2 pairs of legs. The dorsal surface of these larvae were spotted with groupings of hairs, and it was speculated that these hairs were useful in gripping the soil while feeding. However, occasionally a larva would feed in an upright (dorsal up) position. Their heavy elongate mandibles were used to cut food into pieces which were passed to the mouth via the maxillae. Feeding was observed whenever the salve cans were opened, and there seemed to be no increase in consumption when new food was placed in the cans, thus indicating there was no optimum aging of food hosts offered to the larvae.

Larvae dwindled in numbers continuously probably due to lack of our locating their proper food. The last one died at approximately 45 days old. A search was made for larvae at the site of adult collection; however, diggings to a depth of 2 feet into loose sand in locations where mating adults were observed were all unsuccessful in turning up larval stages of the beetle.

Ritcher (1973) wrote the original description for the first 2 larval instars from specimens sent to him by one of us (CSB).

Literature Cited

Hardy, Alan R. 1974. Revisions of *Thyce* LeConte and related genera (Coleoptera: Scarabaeidae). Occ. Pap. No. 20, Dept. of Food and Agric., California.

Hayes, W. P. 1929. Morphology, taxonomy, and biology of larval scarabaeoidea. Illinois Biol. Mono. 12(2):1-119.

Howden, H. F. 1968. Generic relationships of *Thyce, Plectrodes, Dinacoma,* and *Hypotrichia,* with a description of a new genus and species from eastern Texas (Coleoptera: Scarabaeidae: Melolonthinae). Canad. Ent. 100:542-547.

RITCHER, P. O. 1966. White grubs and their allies. Oregon State University Press, Corvallis, Oregon, 219 p.; illus.
RITCHER, P. O. 1973. A description of the larva of *Hypothyce mixta* Howden (Coleoptera: Scarabaeidae: Melolonthini). Coleopt. Bull. 27(3): 113-116.

HARPALUS (OPHONUS) PUNCTICEPS STEPHENS (COLEOPTERA, CARABIDAE) IN NEW YORK AND VERMONT

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ABSTRACT

The palaearctic species *Harpalus (Ophonus) puncticeps* Stephens, previously known in North America only from Long Island, N. Y., is here recorded from Poughkeepsie, N. Y., and Bolton, Vt.

The palaearctic species *Harpalus (Ophonus) puncticeps* Stephens was accidentally introduced in North America, but until now has been reported only from Long Island, New York (Dietrich 1957; Ball 1960b; Lindroth 1968). Six specimens in my possession indicate that this species is spreading in the northeastern United States. Five specimens in my own collection were found by Donald B. Pizzuto in Poughkeepsie, New York, on the following dates: 18-VI-1969 (2 males); 14-VII-1969 (1 female); and 26-VII-1969 (2 females). The sixth specimen is a male in the Ross T. Bell collection at the University of Vermont. It was found by Joyce Bell at Camel's Hump, Bolton, Vermont, on 2-VIII-1972. The specimen was sent to Carl H. Lindroth who confirmed its identification as *Harpalus puncticeps.*

The habitat of this beetle in Europe has been recorded (Lindroth 1945). It lives on bare gravel-loam soil with sparse but high vegetation, often under dried tufts of curly dock (*Rumex crispus*) and Queen Anne's lace (*Daucus).* It has been observed repeatedly on the umbels of Queen Anne's lace. The Vermont specimen was found in a log at 2,800 feet. This unlikely habitat, coupled with its known flying ability (Lindroth 1968), indicate that the Vermont specimen is probably a stray.

LITERATURE CITED

BALL, G. E. 1960b. Carabidae (Latreille, 1810). p. 55-182. *In* R. H. Arnett, Jr., The beetles of the United States. The Catholic University of America Press, Washington, D. C.
DIETRICH, H. 1957. *Harpalus puncticeps* Steph. on Long Island, N. Y. Coleopt. Bull. 11:46.
LINDROTH, C. H. 1945. Die fennoskandischen Carabidae. Eine tiergeographische Studie. I. Wettergren and Kerbers Förlag. Göteborg. p. 1-709.
LINDROTH, C. H. 1968. The ground beetles (Carabidae, excl. Cicindelinae) of Canada and Alaska. Part 5. Opusc. Ent. Suppl. 33:649-944.